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Mani Adeli

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application for:

Steven Teig

Serial No.:

Filing Date: 1/13/02

For: PROBABILISTIC ROUTING METHOD AND APPARATUS

Examiner: <not assigned yet>

Group Art Unit: <not assigned yet>

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PRELIMINARY AMENDMENT

Assistant Commissioner of
Patents and Trademarks
Washington, D.C. 20231

Sir:

This Preliminary Amendment is concurrently filed with the above-entitled application, which is a continuation application of a presently pending application entitled "Routing Method and Apparatus that Utilize Diagonal Routes," filed on December 7, 2001, and having serial number 10/013,819. **Applicants respectfully request that claims 1-26 be canceled (pursuant to the amendment below) before calculation of the filing fee**.

Please amend the application as follows:

IN THE TITLE

Please replace the current title, "ROUTING METHOD AND APPARATUS THAT UTILIZE DIAGONAL ROUTES," with "PROBABILISTIC ROUTING METHOD AND APPARATUS."

IN THE SPECIFICATION

Please delete the "Claim of Benefit to Prior Application" on page 1, lines 1-11, and insert therein a new Claim of Benefit to Prior Applications as follows:

--CLAIM OF BENEFIT TO PRIOR APPLICATIONS

This application is a continuation application of United States Patent Application entitled "Routing Method and Apparatus that Utilize Diagonal Routes," filed on December 7, 2001, and having serial number 10/013,819. This patent application also claims the benefit of the earlier-filed U.S. Provisional Patent Application entitled "Method and Apparatus that Utilize Diagonal Routes", having serial number 60/325,748, and filed 1/19/2001; U.S. Provisional Patent Application entitled "Routing Method and Apparatus", having serial number 60/314,580, and filed 8/23/2000; and U.S. Provisional Patent Application entitled "Routing Method and Apparatus", having serial number 60/337,504, and filed 12/6/2001--

Please delete the "Field of the Invention" on page 1, lines 10-12, and insert therein a new Field of the Invention as follows:

--**FIELD OF THE INVENTION**

The invention is directed towards probabilistic routing method and apparatus.--

On page 5, lines 1-8, please delete the "Summary of the Invention", and insert therein a new Summary of the Invention as follows:

--**SUMMARY OF THE INVENTION**

Some embodiments of the invention provide a method of routing several nets in a region of a design layout. Each net includes a set of pins in the region. In some embodiments, the method partitions the region into several sub-regions that have a number of edges between them. The method (1) for each particular net and each particular edge, identifies an edge-intersect probability that specifies the probability that a set of potential routes for the particular net will intersect the particular edge, and (2) uses the identified edge-intersect probabilities to identify routes for the nets. A potential route for a particular net traverses the set of sub-regions that contain the particular net's set of pins.

In other embodiments, the method partitions the region into several sub-regions that have a number of paths between them. The method (1) for each particular net and

each particular path, identifies a path-use probability that specifies the probability that a set of potential routes for the particular net will use the particular path, and (2) uses the identified path-use probabilities to identify routes for the nets.--

IN THE CLAIMS

Please cancel claims 1-26.

Please add the following claims 27-46.

--27. A method of routing a plurality of nets in a region of an integrated circuit ("IC") layout, each net having a set of pins in the region, the method comprising:

a) partitioning the region into several sub-regions, wherein a plurality of edges exist between said sub-regions,

b) for each particular net, identifying an edge-intersect probability for each particular edge that specifies the probability that a set of potential routes for the particular net will intersect the particular edge, wherein a potential route for a particular net traverses the set of sub-regions that contain the particular net's set of pins; and

c) using the identified edge-intersect probabilities to identify routes for the nets.

28. The method of claim 27, wherein, for each particular net, the edge-intersect probability for each particular edge equals the number of potential routes of the

particular net that intersect the particular edge divided by the number of potential routes of the particular net.

29. The method of claim 28, wherein identifying the edge-intersect probabilities for each particular net comprises:

a) identifying the set of sub-regions that contain each particular net's pins;

b) based on each particular net's identified set of sub-regions, retrieving the particular net's edge-intersect probabilities from a storage structure.

30. The method of claim 27, wherein identifying the edge-intersect probabilities comprises:

for each particular net:

a) identifying the set of potential routes for the particular net;

b) for each particular edge, computing the number of potential routes of the particular net that intersect the particular edge;

c) dividing the computed number of each particular edge by the number of potential routes of the particular net.

31. The method of claim 30, wherein identifying the set of potential routes for each particular net comprises retrieving the set of routes from a storage structure.

32. The method of claim 30, wherein identifying the set of potential routes for each particular net comprises generating the set of routes after partitioning the IC region.

33. The method of claim 27 further comprising:

for each particular edge, computing a sum of the probabilities identified for the particular edge for all the nets;

using the summed probabilities for the edges to predict congestion of the edges;

routing the nets based on the predicted congestion of the edges.

34. The method of claim 27, wherein using the identified probabilities to identify routes for the nets comprises:

a) using the edge-intersect probabilities to predict congestion of the edges;

b) based on the predicted congestion, identifying routes for nets.

35. The method of claim 27, wherein using the identified probabilities to identify routes for the nets comprises:

a) using the edge-intersect probabilities to derive an edge-intersect cost for each edge;

b) using the potential routes and the edge-intersect costs to formulate a linear-programming ("LP") problem;

c) solving the LP problem to identify one route for each net.

36. The method of claim 35, wherein the LP problem is an integer linear programming ("ILP") problem, and solving the ILP problem results in an ILP solution that specifies one route for each net.

37. The method of claim 35, wherein solving the LP problem results in a real-number solution for each net, wherein using the identified probabilities to identify routes for the nets further comprises converting the real-numbered solutions to integer solutions that specify only one route for each net.

38. A method of routing a plurality of nets in a region of an integrated circuit ("IC") layout, each net having a set of pins in the region, the method comprising:

a) partitioning the region into several sub-regions, wherein a plurality of paths exist between said sub-regions,

b) for each particular net, identifying an path-use probability for each particular path that specifies the probability that a set of potential routes for the particular net will use the particular path, wherein a potential route for a particular net traverses the set of sub-regions that contain the particular net's set of pins; and

c) using the identified path-use probabilities to identify routes for the

nets.

39. The method of claim 38, wherein, for each particular net, the path-use probability for each particular path equals the number of potential routes of the particular net that use the particular path divided by the number of potential routes of the particular net.

40. The method of claim 39, wherein identifying the path-use probabilities for each particular net comprises:

a) identifying the set of sub-regions that contain each particular net's pins;

b) based on each particular net's identified set of sub-regions, retrieving the particular net's path-use probabilities from a storage structure.

41. The method of claim 38, wherein identifying the path-use probabilities comprises:

for each particular net:

a) identifying the set of potential routes for the particular net;

b) for each particular path, computing the number of potential routes of the particular net that use the particular path;

c) dividing the computed number of each particular path by

the number of potential routes of the particular net.

42. The method of claim 41, wherein identifying the set of potential routes for each particular net comprises retrieving the set of routes from a storage structure.

43. The method of claim 41, wherein identifying the set of potential routes for each particular net comprises generating the set of routes after partitioning the IC region.

44. The method of claim 38 further comprising:

for each particular path, computing a sum of the probabilities identified for the particular path for all the nets;

using the summed probabilities for the paths to predict congestion of the paths;

routing the nets based on the predicted congestion of the paths.

45. The method of claim 38, wherein using the identified probabilities to identify routes for the nets comprises:

a) using the path-use probabilities to predict congestion of the paths;

b) based on the predicted congestion, identifying routes for nets.

46. The method of claim 38, wherein using the identified probabilities to identify routes for the nets comprises:

a) using the path-use probabilities to derive an path-use cost for each path;

b) using the potential routes and the path-use costs to formulate a linear-programming ("LP") problem;

c) solving the LP problem to identify one route for each net.--

IN THE ABSTRACT

On page 175, lines 1-8, please delete the "Abstract of the Invention", and insert therein a new Abstract of the Invention as follows:

--ABSTRACT OF THE INVENTION

Some embodiments of the invention provide a method of routing several nets in a region of a design layout. Each net includes a set of pins in the region. In some embodiments, the method partitions the region into several sub-regions that have a number of edges between them. The method (1) for each particular net and each particular edge, identifies an edge-intersect probability that specifies the probability that a set of potential routes for the particular net will intersect the particular edge, and (2) uses the identified edge-intersect probabilities to identify routes for the nets. A potential route for a particular net traverses the set of sub-regions that contain the particular net's set of pins.

In other embodiments, the method partitions the region into several sub-regions

that have a number of paths between them. The method (1) for each particular net and each particular path, identifies a path-use probability that specifies the probability that a set of potential routes for the particular net will use the particular path, and (2) uses the identified path-use probabilities to identify routes for the nets.--

REMARKS

This Preliminary Amendment is concurrently filed with the above-entitled application, which is a continuation application of a presently pending application entitled "Routing Method and Apparatus that Utilizes Diagonal Routes," filed on December 7, 2001, and having serial number 10/013,819. In this Preliminary Amendment, Applicants have changed the title of this application, inserted a reference to the related parent application, canceled claims 1-26, added claims 27-46, and replaced the

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Summary and Abstract. Accordingly, claims 27-46 are currently pending in this application.

Respectfully submitted,

STATTLER, JOHANSEN & ADELI LLP

Dated:1/13/02

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